METHOD AND DEVICE

The present invention relates to a method of and device for regulating the temperature of printing devices, and in particular devices comprising one or more arrays of ink jet valves.

Printers are used, to give just one example, to print onto a print substrate such as products and packaging on assembly lines, carpets, fabrics, etc. Print heads comprising arrays of many print elements are arranged together to print across a defined region of the print substrate. If the printing is in colour then it is necessary to have print heads that can print in black, cyan, magenta and yellow.

According to a first aspect of the present invention there is provided a method of regulating the temperature of a print head comprising one or more print elements, the method comprising the step of using a temperature control medium to regulate the temperature of one or more of the print elements.

The temperature control medium may be pumped from a storage means to the one or more print elements and/or the temperature control medium may be pumped from the one or more print elements back to the storage means. Preferably, the temperature of the print head is regulated based on the temperature difference between the temperature control medium pumped from the storage means

to the one or more print elements and the temperature control medium pumped from the one or more print elements back to the storage means. The temperature control medium may also be a print medium and preferably an ink.

According to a second aspect of the présent invention there is provided a print head comprising: one or more print elements; temperature control medium storage means, the storage means being in fluid communication with the one or more print elements such that, in use, temperature control medium can circulate from the storage means to the one or more print elements and thence to the storage means.

Preferably the print head further comprises temperature control means that, in use, heats or cools the temperature control medium held in the storage means. The print head may further comprise a first conduit for providing fluid communication from the storage means to the printing elements and a second conduit fro providing fluid communication from the printing elements to the storage means. Preferably the print head comprises one or more temperature sensors. The one or more temperature sensors may be arranged to measure the temperature of one or more print elements and/or one or more temperature sensors may be arranged to measure the temperature of the temperature control medium in the first conduit and or the second conduit.

A preferred embodiment of the invention control will now

be described by way of illustration only and with respect to the accompanying drawings, in which

Figure 1 shows a schematic depiction of a known print head; and

Figure 2 shows a schematic depiction of a print head according to the present invention.

Figure 1 shows a schematic depiction of print head 100 comprising control means 150 and rows 160a, 160b, 160c ... of printing elements. The rows of printing elements are physically located in a vertical array so that the valves can deposit a two-dimensional matrix on a print substrate The print head further comprises ink reservoir 120 and ink conduit 130 such that ink can be supplied from the reservoir to the printing elements. Each element may be individually connected to the conduit or there may be a manifold associated with each of the rows of printing elements such that the conduit is connected to each row of printing elements.

Modern printing technology enables printing at very high speeds, for example in excess of 1kHz (see, for example, WO03/033951, PCT/GB2003/000633 and GB 0316266.6) and for the electro-magnetic valves used, for example, in drop-on demand ink jet printers the drive circuits generate significant amounts of heat. When a number of print heads are closely arranged together, and especially when colour printing is used, it is difficult to provide adequate cooling to the print heads by blowing cool air over the

print heads.

If the print heads overheat then this can have serious effects on the print quality as the electronic circuits may be damaged (or may fail) and the ink properties may be affected, for example the viscosity of the ink may be decreased such that it is no longer suitable for the printing application, or the long-term stability of the pigments in the ink may be affected.

Figure 2 shows a schematic depiction of a print head 200 according to the present invention. The print head comprises control means 250, rows 260a, 260b, 260c ... of printing elements located in a vertical array so that the valves can deposit a two-dimensional matrix on a print substrate, ink reservoir 220 and first ink conduit 230. The print head further comprises second ink conduit 235 and temperature control means, which is coupled to the ink reservoir.

In operation, the ink is pumped from the ink reservoir to the rows of printing elements via the first ink conduit. When a printing element is operated some ink will be expelled from the printing element and onto the print substrate and the ink pumped from the reservoir will replace the ink used in printing. Furthermore, some of the ink will be returned to the ink reservoir via the second ink conduit, from where the ink may be re-circulated again.

If the operation of the print head, and other adjacent or proximate print heads, causes the temperature of the print heads to increase then the temperature of the ink in the second conduit will be greater than that of the ink in the first conduit. The ink may thus be used as a heating or a cooling medium with the temperature control means regulating the temperature of the ink held within the ink reservoir before it is then re-circulated via the first ink conduit. By suitable control of the temperature control means, and thus the temperature of the ink, the flow of cooled ink to the print elements and then back to the ink reservoir, via the first conduit and the second conduit, enables the temperature of the print elements to be regulated.

The temperature of the print elements may, in one embodiment of the invention, be inferred by measuring the temperature of the ink as it enters the first conduit from the ink reservoir and as it returns to the ink reservoir from the second conduit. In this case ink temperature sensors 280a, 280b may be used to measure the temperature of the ink passing through the first and second conduit respectively. It may be possible to assume the temperature of the ink in the storage means and infer the temperature of the print elements solely based on the temperature of the ink in the second conduit.

In a preferred embodiment of the invention, the print head further comprises one or more temperature sensors 270a, 270b, 270c, ... located on or near to the print element.

Although Figure 2 shows one temperature sensor being attached to each of the circuit boards to which the print elements are attached, it will be understood that one or more temperature sensors may be attached to one or more of the circuit boards or one or more of the print elements. The data from the temperature sensors is polled by the control means 250 and this data is used to manage the temperature control means. It will be understood that some of the print elements may be significantly hotter than other print elements. In this case additional parallel fluid conduits may be provided in order to supply the necessary cooling to those print elements.

It will be understood that any cooling mechanism may be used to cool the temperature of the ink reservoir as long it is able to provide adequate cooling to the reservoir. Examples of suitable technologies include, without limitation, heat-sinks and fans mounted on the reservoir, thermo-electric coolers, heat exchangers integrated with the reservoir, pumping hot ink into a radiator which may be further cooled, etc. Furthermore it will be readily understood that there may be some scenarios in which it is necessary to heat the ink, for example to maintain the viscosity of the ink within a pre-determined range and in this case the temperature control means may further comprise heating means, for example one or more electrical heating elements.

The invention is applicable to all manner of print heads that use ink and for which temperature regulation may be

required, and not just drop-on demand ink-jet printers.